628.1
J92

THE WATER SUPPLY OF BURLINGTON, VERMONT.

REPORT TO

HON. GEO. F. EDMUNDS,

BY

WM. PIERSON JUDSON, C. E.,

MEM. AMER. SOC. CIV. ENG.

1884.

To the People of Burlington, interested in our Water Supply.

During the months of May, June and July, 1884, there was an unusual amount of sickness, in our city, from typhoid fever, and the number of cases was so great, that our physicians regarded it as an epidemic for this locality, and arising from some unusual general source.

Our city has been considered—and justly so—as being quite free from epidemics of this character.

Many of our older physicians have often asserted that typhoid fever rarely, if ever, originated here, and that the few cases which have occurred from year to year, were mostly imported from other towns.

The *source* of such an epidemic as visited us during the past season, has been the anxious inquiry of the citizens of Burlington.

Our physicians and many of our people believe that the water supply was the most probable source, from the fact that of late years, most of the city sewage and surface drainage has discharged into the same basin and currents of water, from which our city is supplied.

In the month of July five hundred and seventy-five (575) of our citizens signed a petition to the Honorable Board of Aldermen, which read as follows :

To the Mayor and Board of Aldermen of the City of Burlington.

Gentlemen :

The recent epidemic of fever which has prevailed here in such an unexampled manner shows clearly that the sanitary condition of our city is defective in some important point. It is the opinion of the medical profession that the defect can be traced to the water. It is also their opinion that a much purer supply of water can easily be obtained by extending the supply pipes so that the water shall be taken from outside the breakwater.

Your petitioners believe that at present the water is liable to contamination from the sewerage and drainage of the city, from the refuse and filth of the large number of canal boats and other boats lying at our wharves, and from the deposit in our harbor when disturbed during the prevalence of strong westerly or southerly winds,

We believe that the prospect of the prevalence of cholera another season, if not this, demands immediate action, in order that we may be protected from it as fully as possible.

We believe that the cost of extending the supply pipes will be less than the cost of the sickness directly traceable to this cause for this season alone.

We believe that our citizens, and that strangers coming here, have lost confidence in the purity and healthfulness of our water supply, and that it is of utmost importance to the growth and prosperity of our city that confidence should be regained.

We believe that if water is obtained from beyond the breakwater it will be pure and healthful. Therefore, we, your petitioners, pray that your honorable body will take immediate action in the matter *and in such a manner that the whole expense of the extension shall be provided for by taxation on the grand list of the city and not by any charge upon or increase of rates against the users of water.*

[The clause in italics was added by Senator Edmunds when he signed the petition].

A committee was chosen at a citizens' meeting called for that purpose on the fourth of August to present the petition.

At a meeting of the Board of Aldermen held Aug. 11, the petition was presented in an earnest manner.

We learn that previous to and since that time the Water Committee have expended some time and money in securing analyses of the water taken from different points of the harbor and lake.

We do not wish to comment upon this plan of ascertaining the probable impurities of our water supply, but place before you a communication from our resident chemist, Prof. A. H. Sabin, U. V. M., upon the subject.

BURLINGTON, VT., Dec. 15th, 1884.

DR. L. M. BINGHAM :

In reply to your inquiry as to my views about our city water supply, I reply that while the question whether or not the water has had any bad effect in the past is chiefly a question for the local medical men to decide. I have no doubt in my mind that as it is taken at present it is at least unsafe. Not only do all the city sewers empty into the bay from which the water is taken, but from the situation of our city every rain storm washes off whatever filth may be on the whole surface of the more densely inhabited part of the city directly into the same bay. This is one of the greatest advantages of our situation, in a sanitary point of view, producing that cleanliness for which Burlington is remarkable among manufacturing towns of its size ; but it is only the more reason why we should not drink such water. Besides this the large numbers of boats which, while navigation is open, constantly crowd into the principal portion the lake are and must necessarily be continually throwing overboard all sorts of refuse and dirt, and that in all parts of the harbor. If the bay were merely a little lake as large

✓ p 1602

as the harbor, no one would think for a moment of drinking the water ; but while it is commonly said that our principal safety lies in the fact that this dirt settles to the bottom and does not get to the mouth of the supply pipe, it should be remembered that whatever connection the harbor has with the broad lake tends to stir up this mess, and that it is just as likely to carry it to the pipe as away from it.

The question is often asked, Can we tell whether water is good or not by a chemical analysis? The value of water for manufacturing purposes can be determined with the utmost nicity by chemical means, but the question as to its absolute safety for drinking purposes can not be so easily settled. If water contains enough impurities they may be detected by chemical means, and such water should always be rejected if the analysis shows it to be unsafe. But it is not the quantity but the quality of the impurities that is of importance, and water may contain dangerous matters without showing by the amount of impurity that it is unsafe. I do not think that a chemist is justified, except in extreme cases of foulness, in passing judgment on a sample of water without having made a survey of the locality and considered the history of the water. Dr. Hassal, one of the very foremost of English authorities on such matters, says : "It has never been contended by chemists that the organic matters determined by them in water constitute the injurious constituents, the *materies morbi* in water ; they simply regard the quantities in which they are present, combined with the circumstances under which they occur, as the measures of the impurity to which they are exposed, and as indicating the degree of liability of any water to become contaminated with the special poisons of cholera, typhoid fever, or other disease." So also it is said by Dr. Simon, chief medical officer of the privy council of Great Britain, in a book reprinted in this country by the Massachusetts State Board of Health, "these tests, it must be remembered, are tests only of most general kind. Confessedly they do not touch the *corpus delicti*, but only certain conditions to which it is or may be collateral ; and their negative findings are consequently not entitled to the same sort of confidence as their positive." Sometimes our city water analyzes well, and sometimes it does not ; but when it does it is not for me to say that it is absolutely safe, though when it does not I am justified in pronouncing it dangerous.

In conclusion I will say that I have heard very unfavorable—and indeed unjust—comments on our water supply in Montreal, Boston, New York and Philadelphia ; and when we consider the fact that our city is beginning to be a summer resort the importance of keeping ourselves so far on the safe side as to remove all occasion for such remarks can hardly be overestimated

A. H. SABIN.

Our townsman, Hon. Senator Edmunds, being anxiously interested in the condition of our water supply made arrangements with Mr. Wm. Pierson Judson, C.E., to make scientific observations regarding the water currents in our harbor and bay, thus learning the possibility and probability of our water supply becoming contaminated with sewage. And the principal object of

this pamphlet is to place before the citizens of Burlington, the results of that investigation :

HON. GEORGE F. EDMUNDS,

UNITED STATES SENATE, WASHINGTON, D. C.

SIR :

In compliance with your wish that I should examine the system of water supply for the City of Burlington, Vermont, and determine as to its sanitary character, I have made the necessary observations and report as follows :

The water is supplied to the City from reservoirs, into which it is pumped, from Lake Champlain, through a pipe whose inlet is at the end of a crib, which projects fifty feet beyond the wharf line, or water front, of the city : the wharves extending half a mile, to the north and the south, on each side of this crib.

In front of this wharf line, about (900) nine hundred feet west from it and generally parallel with it, is the detached breakwater of about four thousand feet in length, which shelters the wharf front and forms the harbor : this harbor, which lies between the breakwater and the wharf front, being open to the Lake at its north and south ends.

From this harbor, or semi-enclosed area, the city water supply is taken, and into this area the entire system of city sewerage and surface drainage flows.

The water works inlet is near the north end of the harbor, while the main sewer outlet is near its south end : the distance between the two, along the wharf line, being about (4000) four thousand feet. The harbor being open at both ends, the lake current flows through it.

The natural trend of the current at this point, when not affected by wind, is from north to south: the reverse of the main lake current, which is here deflected by Rock Point, a mile north of the city, so as to form an eddy or counter current. If this counter current uniformly flowed through the harbor, from north to south, the city sewage would be carried away from the water works inlet, and the water supply would be as comparatively pure as its close proximity to the wharves and the shore line would permit.

Definite data as to the force and constancy of this flow were therefore first sought.

During a dead calm on October 26th, 1884, careful current observations were made fifty feet out from the Water Works inlet.

The observations were made at the surface, at mid-depth, and at bottom, and all showed a gentle but well-defined flow, from north to south, along a line parallel with the wharf front.

The accompanying table gives the details of these observations.

Current observations fifty feet off water works inlet during calm on Oct. 26, 1884.

Depth along base line twelve feet: smooth sandy bottom.

Depth of center of current vane below surface.	Time of Start.	Time of Finish.	Length of Time of Immersion	Distance traveled by current vane.	Rate of Current in feet per minute.	Direction of Current.	Remarks.
$1\frac{1}{2}$ feet.	h. m. s. 12 23 0	h. m. s. 12 37 0	m. s. 14 0	$33\frac{1}{3}$ feet.	$2\frac{38}{100}$ feet	North to South	Surface of water perfectly smooth and air calm.
6 feet.	h. m. s. 12 06 30	h. m. s. 12 15 40	m. s. 9 10	$33\frac{1}{3}$ feet.	$3\frac{64}{100}$ feet	ditto	
10 feet.	h. m. s. 11 37 30	h. m. s. 11 53 0	m. s. 15 30	100 feet.	$6\frac{45}{100}$ feet	ditto	

Mean velocity, as computed from the above table by Marr's formula, equals $3\frac{49}{100}$ feet per minute, from North to South.

Observations were next made to determine the effect, if any, of southerly wind : Winds from the south to south west being of frequent occurrence, and this being also the direction of wind which would be most likely to interrupt the counter current or eddy, and to cause the flow to be from the south.

During a strong wind of thirty miles per hour on October 27th, 1884, observations similar to those detailed above were therefore made at the same point, and with the same apparatus.

In order to determine the mean velocity and the direction of the current, unaffected by the strong wind which was blowing, the current indicator which was used was submerged, so as to be free from any action of the wind, and it was so arranged that it could be set at any depth, so as to move with the water at that depth and thus show, by range observations from the wharf, the actual direction and velocity of the flow at the particular depth desired.

As before, the observations were made near the surface (one and one half feet beneath it), at mid-depth and near the bottom : the depth of water at the place being twelve feet and the bottom being smooth sand.

The observations showed a definite current from the south to the north, or in the direction which would carry the sewage toward the water works inlet.

Current observations fifty feet of water works inlet during calm on Oct. 26, 1884.

Depth along base line twelve feet: smooth sandy bottom.

Depth of center of current vane below surface	Time of Start.	Time of Finish.	Length of Time of Immersion.	Distance traveled by current vane.	Rate of Current in feet per minute.	Direction of Current.	Remarks.
	h. m. s.	h. m. s.	m. s.				
1½ feet.	12 23 0	12 37 0	14 0	33⅓ feet.	$2\frac{34}{100}$ feet.	North to South	Surface of water
	h. m. s.	h. m. s.	m. s.				
6 feet.	12 06 30	12 15 40	9 10	33⅓ feet.	$3\frac{64}{100}$ feet.	ditto	perfectly smooth and
	h. m. s.	h. m. s.	m. s.				
10 feet.	11 37 30	11 53 0	15 30	100 feet.	$6\frac{45}{100}$ feet.	ditto	air calm.

Mean velocity, as computed from the above table by Marr's formula, equals $3\frac{49}{100}$ feet per minute, from North to South.

Current observations fifty feet off water works inlet during strong wind of October 27, 1884.

Depth of center of current vane below surface	Time of Start.	Time of Finish.	Length of Time of Immersion.	Distance traveled by current vane.	Rate of Current in feet per minute.	Direction of Current.	Remarks.
1½ feet.	h. m. s. 12 05 30	h. m. s. 12 10 0	m. s. 4 30	50 feet.	$11\frac{11}{100}$ feet.	South to North	Wind strong from South since 4 a. m. for 8 hours. During observations, 30 miles per hour from South.
6 feet.	h. m. s. 11 54 30	h. m. s. 11 58 0	m. s. 3 30	50 feet.	$14\frac{30}{100}$ feet.	ditto	
10 feet.	h. m. s. 11 31 0	h. m. s. 11 40 0	m. s. 9 0	20 feet.	$2\frac{22}{100}$ feet.	ditto	

Mean velocity, as computed from the above table by Marr's formula, equals $13\frac{70}{100}$ feet per minute, from South to North.

The accompanying table gives the details of these observations.

Current observations fifty feet off water works inlet during strong wind of October 27th, 1884.

Depth of center of current vane below surface.	Time of Start.	Time of Finish.	Length of Time of Immersion.	Distance traveled by current vane.	Rate of Current in feet per minute.	Direction of Current.	Remarks.
	h. m. s.	h. m. s	m. s.				Wind strong from South since 4 a. m. for 8 hours. During observations, 30 miles per hour from South.
$1\frac{1}{2}$ feet.	12 05 30	12 10 0	4 30	50 feet.	$11\frac{11}{100}$ feet.	South to North	
	h. m. s.	h. m. s	m. s.				
6 feet.	11 54 30	11 58 0	3 30	50 feet.	$14\frac{30}{100}$ feet.	ditto	
	h. m. s.	h. m. s.	m. s.				
10 feet.	11 31 0	11 40 0	9 0	20 feet.	$2\frac{22}{100}$ feet.	ditto	

Mean velocity, as computed from the above table by Marr's formula, equals $13\frac{70}{100}$ feet per minute, from South to North.

NOTE.—Marr's formula for mean velocity is, $Vm = V\frac{1}{2}D \times 0.958$.
Given in U. S. Engr. Dept. Report, 1884, by Maj. Alex. Mackenzie.

Examination of this table will show that the velocity was greater at mid-depth than at surface, which indicates that the apparatus was not affected by the wind.

It being thus established that the current was flowing from south to north, any tests of the water as to whether it contained sewage, were superfluous; as it was evident that the flow of all the city sewage, after its dilution in the water at the south end of the harbor, was directly along the wharf front and to and across the water works inlet.

A specimen of water was, however, taken during these last current observations on October 27th, from directly at the water works inlet, and one and one half feet above the bottom.

The water was found to be very clear and transparent, but in an half pint, there were plainly visible some fifty particles of light organic matter, apparently from sewage, each particle being about one thirtieth of an inch in diameter.

This specimen of water is sealed, and is herewith submitted With it is a similar specimen, taken at the same point and depth, during the calm of October 26th : and also two specimens of water taken from the open Lake, one hundred feet outside the breakwater, and directly westward 1000 feet from the water works inlet.

One of these was taken during the strong wind of October 27th, and the other during a calm.

Each is from one and one half feet above the bottom and about forty feet below the Lake surface.

Specimens of the surface of the lake bottom at the water works inlet, in 12 feet depth, and at 100 feet outside the breakwater in about 40 feet depth, are also herewith. All the specimens are marked and signed, and the water specimens are sealed.

An examination of the mean rate of current, as indicated by the last observations given above, shows that during a southerly wind, particles and solutions of the sewage which flow from the sewer outlet at any given time, may in five hours afterward be drawn into the water works inlet.

This feature however, unpleasant as it appears to be, is not the most serious defect which results from the present location of the inlet.

During calm weather, or northerly winds, when the current is from north to south, and is carrying the sewage away from the inlet, the drift of the flow is onto the sandy shallows and the beach lying to the south of the city.

Upon these shallows and this beach, extending along the shore for a mile and a quarter southward, the heavier portions of the sewage matter are deposited.

When the wind changes to the south or south-west, and the waves from the open lake roll in upon the beach, this foul deposit is stirred up in the breakers, and is then carried back into the Harbor by the littoral current, and thence along the wharf front, past, or into, the water works inlet as before described.

Such of the material as is not then drifted past Rock Point, is deposited on the bottom to the north of the harbor, whence it is again returned with a subsidence, or a change, of the wind.

Thus it appears that the water supply can never be said to be wholly free from probability of sewage contamination.

Not only is the sewage so carried back and forth along the water front by the varying current, but the refuse from the gas works, and the surface and street washings from the lower part of the city,

find their way into the slips, where they settle until they are stirred up by the waves and are then carried out to add their quota: So that any violent storm may be expected to show its effects soon afterward, in more or less pronounced symptoms of sewage poisoning among the water users.

The only effective remedy is a simple, though a somewhat costly one: It being to extend the inlet pipe one thousand (1000) feet across the harbor, to the outer face of the breakwater, and into the pure water of the open lake.

There would be no further advantage from extending the inlet pipe beyond the outer face of the breakwater, as above indicated, unless it were carried out past the line joining the points which form the bay. The water which would thus be reached would be but little better than that at the outer face of the breakwater, and the increase in cost would be out of proportion to the benefit derived, as it would require a further extension of forty-five hundred (4500) feet, and an expensive crib in ninety (90) feet depth.

Pure water can be obtained at a minimum of cost, and without stopping the water supply, by laying from the present inlet, across the harbor, an iron main with Ward's flexible joints. This can safely be placed upon the bottom, from floats. Dredging would be required only in the shallow water at the shore end, and submarine work would only be needed at the terminus.

Permission could possibly be obtained from the Engineer Department to place the inlet in a crib of the breakwater, and thus avoid the expense of a special construction.

If it is desired, I can furnish a detailed plan and estimates for the work suggested.

I am sir,

Yours very respectfully,

WM. PIERSON JUDSON, C. E.

Member Amer. Soc. Civ. Engrs.

Oswego, New York,

November 10th, 1884.

We also add a communication from Senator Edmunds :

UNITED STATES SENATE,
WASHINGTON, D. C., Nov. 28, 1884.

MY DEAR SIR :

I have yours of the 25th, enclosing printed proof of the communication made to me by Mr. William Pierson Judson, civil engineer, who was in charge of the breakwater repairs this summer at Burlington, on the subject of the state of the water in the lake as connected with our city water works. I most earnestly hope that our city authorities and people will take the matter up and extend the water pipe to the outside of the breakwater at the earliest possible moment. I think the whole expense of it should be borne by a tax on the grand list, so that the water rates will not have to be increased. Whatever the expense may be I think will be money well expended, not only for the health of the city but for its sense of security against the danger of epidemics and for its reputation in the minds of the people who may come to town as travellers or otherwise.

Very truly yours,

GEO. F. EDMUNDS.

DR. L. M. BINGHAM, Burlington, Vt.

With all these facts before us are we to continue the use of water taken from the point where it now is. Are the citizens of Burlington willing to let the matter of obtaining better water rest where it now is ?

our water supply is as good as can be found in the lake ?

We earnestly hope, that our people will at once take this subject into consideration and devise means whereby we may be promptly relieved of the necessity of using water so liable to contamination from sewage.

At the same time arrangements are made for the change of the localities of the inlet pipes, some plan should be perfected for the thorough cleaning out of the reservoir. Never since its construction has it been entirely emptied of the filth deposited there ; at present there is on the bottom of the reservoir at least twenty inches of decomposing animal and vegetable matter ; and with the present construction of the reservoir there is no available means of removing it.

Sanitary improvements are being agitated in all Harbor and Port towns, with reference to a probable epidemic of cholera. And suspicious water supplies are the first to be considered.

3 0112 072349506